

Part 3 ASH AND SLAG HANDLING

3.7. Analytics

3.7.31. Key issues of coal ash handling in Russia

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ABSTRACT

In 2010 total production of coal combustion products (CCPs) of the energy sector of the countries world-wide made about 800 million tons, the main of them are ash and slag. In the energy sector in many countries, coal is one of the main fuels and its share in the fuel mix in recent years tends to grow. In this regard, the issues concerning the efficient addressing the coal ash handling problem are becoming more relevant. The situation in Russia is exacerbated by the fact that ash ponds of the vast majority of coal-fired power plants and other solid-fuel power stations (hereinafter - coal-fired power plants) are close to their design filling. This puts the Russian power engineers before the urgent need to take effective measures to address the coal ash handling problem, despite the fact that they are by-products of TPPs.

In the countries of the world the coal ash problem is solved differently. However, there is a positive international experience in effective addressing the coal ash handling problem, which would be very useful for Russia if we really want to be among the leaders in terms of beneficial use of ash in various sectors of the economy and reduce the harmful effects of coal-fired plants on the environment. First of all, Russia should create a national body - a Centre responsible for coordination of all Federal and Regional Ministries and Agencies to deal effectively with coal ash.

In addition, it is necessary to introduce the practice of mandatory external professional expertise of technical solutions at all stages of projects for applying the best available techniques (BAT) not only in the field of coal ash handling, but also in the field of ecology of power engineering of coal-fired power plants in general.

One of the most important conditions for more complete introduction of the best world experience of BAT application is information support of activity of the coal-fired TPPs on the basis of a permanent system research on coal ash handling and ecology of power engineering. The research results should be placed in the electronic information systems of the open access for the mandatory use not only in different industries, but also for training and retraining of specialists in coal ash handling, as well as for the formation of public opinion on the best ways of addressing the coal ash problem.

One of the most effective forms of information exchange between the countries of the international community on coal ash handling is participation in activity of international organizations dealing with CCPs and relevant international conferences or workshops.

Harmonization of legislation on coal ash handling is one of the essential conditions for effective introduction of world experience in BAT application not only in the field of coal ash handling, but also in the field of ecology of power engineering of coal-fired power plants in general.

1. INTRODUCTION

According to [1] and [2] in 2010 total production of coal combustion products (CCPs) of the energy sector

of the countries world-wide made about 800 million tons; about 53% of CCPs of that amount were utilized. In many developed and developing countries of the world a level of CCPs utilization, the main of which is coal ash, ranges from 40 to 100% of their annual output. Fig. 1 and 2 shows the level of production and utilization of CCPs in various countries in 2010, according to [1] and [2].

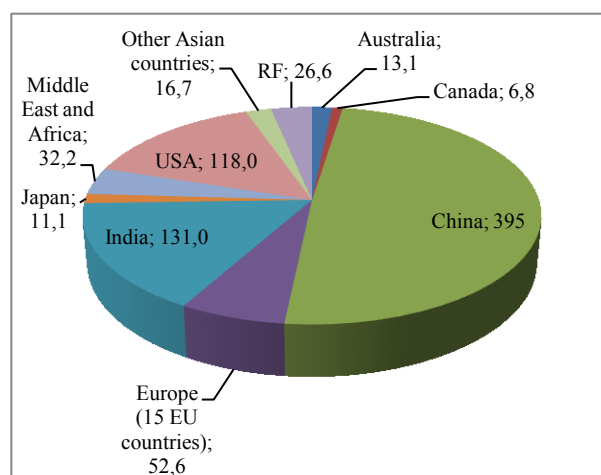


Fig. 1. Production of CCPs in different countries in 2010, mln t.

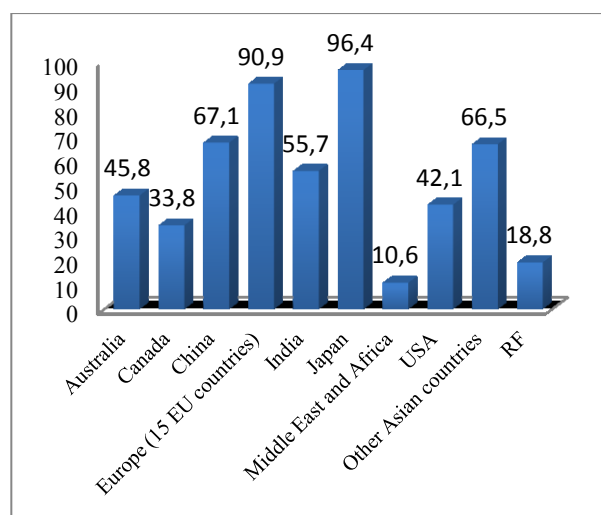


Fig. 2. Utilization of CCPs in different countries in 2010, %.

For example, in the U.S. in 2012, the level of utilization of CCPs increased by 5% compared to 2010 and amounted to about 47%. Moreover, most of the by-products were used in the construction industry [3]. In Europe (15 EU countries) in 2010 the level of beneficial use of CCPs made about 52%; and considering mine

backfilling is was about 90% [4]. By that, in EU countries new coal-fired power units are being introduced. In Australia in 2012 the level of beneficial use of CCPs was about 42%, 79% of which was used in high-tech applications, for example, in production of cement binders, concrete and mineral fillers [5]. In India in 2012, the level of utilization of fly ash from TPPs was about 50% at the level of its production of 200 million tonnes, that is by 70 million tonnes more than in 2010 [6]. In Russia, according to the expert estimation, the level of coal ash utilization is less than 20% out of 27 million tons produced.

What explains this very low rate and how to solve the coal ash handling problem in Russia? This will be discussed below.

2. LEGISLATION IN THE FIELD OF COAL ASH HANDLING

It should be noted that in the countries world-wide there is no single legal definition of ash. In this regard, it is not clear, if ashes are wastes, products or recycled materials? In addition, the experts dealing with coal ash don't also operate with the generally accepted terminology. Currently, attempts are being made by the members of the World Wide Coal Combustion Products Network - www.wgccpn.org (IACEE MPEI is a part of the Network) to develop a common terminology for ash generated from combustion of coal and other solid fuel (peat, pet coke, garden and wood industry wastes, as well as other solid residues of organic origin). The legal definition of ash in different countries is mainly based on national legislation.

For example, in EU coal ash is considered to be a product after successful completion of the procedure REACH, which entered into force on 1 June 2007. In the UK ashes received the "end-of-waste" status according to EU Directive 2008/98/EC dated November 19, 2008. In U.S. ashes are currently identified as products or wastes, depending on the legislation of the relevant State. In accordance with the legislation of South Africa ash and slag are wastes, although in practice they are products. Changing the environmental legislation in Australia resulted in receiving by CCPs the status of products, and no wastes, although until recently they were officially wastes, as it is now accepted in Russia. Although before USSR breakup about 25 million tons of coal ash was beneficially used in various industries in their annual production of about 120 million tons

Thus, for an effective addressing the coal ash handling problem it is, firstly, necessary to develop a terminology unified for all countries for definition of ash, generated from coal combustion or co-combustion with other solid fuels, and to fix it in national laws. It should be noted that in the normative document of electric power industry [7] of 1997 coal ash was defined as follows:

Ash (fly ash) – particles of mineral residue of solid fuel, including a certain amount of the unburnt carbon (unburnt organic part of fuel), taken out by flue gases from the boiler furnace.

Bottom ash / boiler slag – particles of mineral residue of solid fuel, including a certain amount of the unburnt carbon, produced in furnaces of pulverized coal combustion boilers, falling out of the flame of flue gas flow in the boiler furnace and evacuated from the bottom ash/boiler slag extractor of the boiler with size up to 40 mm or coming from the furnace of the FB/CFB-boilers through the bottom ash/boiler slag cooling units to the extractor with size up to 10 mm.

Ash and slag materials (ASM) – ash and slag with initial properties, ash and slag mixture and products of their beneficiation.

Unfortunately, it should be noted that the later work on changing the national legislation of Russia on determination of coal ash as mineral raw material of the man-made origin hasn't been conducted, although the authors of the present paper put forward such proposals. For example, in the XX century the work on Certification of hygienic quality of commodity products, produced using coal ash and of coal ash as commodity products has been suggested to RAO "UES of Russia". Performance of this work would result in development of the draft legal document of the federal level, mandatory for application by licensing and supervisory authorities of all levels, design and operating organizations in the power sector, as well as by processing companies. The main objectives of this work would be:

- development of a legal document having direct action with clear and comprehensible procedure for certification of hygienic quality of ash as a commodity product, and commodity products manufactured with the use of TPP ash without many page volumes of crafty interpretations;
- minimizing the possibility of subjectivity, arbitrariness and corruption of representatives of supervising and licensing authorities at all levels at addressing the coal ash handling issues.

However, these proposals found no support in RAO "UES of Russia". The same work was offered in JSC "Inter RAO UES". But it was also unclaimed.

It seems that coal ash could be defined as follows: "Coal ash is a mineral raw material of the man-made origin, being a commercial product after certification of commodity properties and used in different sectors of the economy. In the case of permanent coal ash storage at disposal sites it refers to wastes".

One of the most important factors to increase the level of beneficial use of coal ash is to harmonize the applicable legislation of the countries world-wide, especially in should refer to the countries - trade partners, for example, Russia and EU countries. Without solving this problem, effective spreading of the world's best available technologies in the field of coal ash handling will unlikely happen.

For the harmonization of national legislations in the field of coal ash use all over the world it's necessary to provide an open access not only to national regulation, but also to normative documents (standards, directives, etc.), regulating various issues of coal ash handling. It's a paradox, when the existing standards relating to coal ash use in various sectors of the economy are no freely

available, although we are concerned about the effective solution of the coal ash handling problem and preservation of the natural environment. It turns out that the world community is deprived of the opportunity of free access to knowledge about the best ways of effective addressing the problem on protecting the environmental from industrial impact of coal-fired power plants. This is, probably, wrong. Every citizen of the world community is the taxpayer and has the right to know how to have a better life, without any payment.

3. ABSENCE OF THE BODY RESPONSIBLE FOR THE COAL ASH HANDLING ISSUES

Statistics on production and utilization of coal ash. It should be noted that in the majority of the countries (including Russia) there is no open sufficient complete and accurate operational information on volumes of coal ash production and utilization in all sectors of the economy, including the amounts and directions of their useful application. At the same time, for example, in the United States and Australia, such relevant information is published by national CCPs associations. ECOBA also publishes such information, but with delays of two to three years for EU-15. Information on EU-27 is presented with a long delay. The same applies to the transboundary movements of ash.

Absence of a single Centre responsible for addressing the coal ash handling problem. The most effective way to deal with coal ash in Russia would be to create a single state body - the Center of responsibility for coordination of all Federal and Regional Ministries and Agencies to deal effectively with coal ash. Creating such a responsibility Centre would be the first step for implementation of the program-target method to address coal ash handling problem through the development and implementation of effective state policy in this field, which currently does not exist.

One example of an effective solution of the coal ash handling problem at the state level is establishment of the Fly Ash Mission in India in 1994. Its activity resulted in raising the level of ash use from 1 million tons at the year of its creation up to 100 million tons in 2012. Currently hundreds of centers and laboratories are dealing with ash issues, thousands of people are working on R&D; demonstration projects are introduced across the country, 15 new standards have been implemented, etc.

And what does Russia have today for effective addressing the coal ash handling problem?

- no single state responsibility center for addressing the coal ash handling problem;
- no holistic set of legal and regulatory documents, encouraging maximum beneficial coal ash use for replacement of the natural resources;
- no target state funding of researches in the field of coal ash handling;
- management of energy companies isn't interested in effective addressing the coal ash handling issues;
- extremely low information support of activity of energy companies and specialized organizations in the field of coal ash;

- lack of the trained personnel working in power companies and specialized organizations in the field of coal ash handling.

At the same time, it's not so bad in Russia. For example, in the Siberian Federal District representatives of the JSC "TGC-11" and local authorities developed a regional program to address the coal ash handling problem in the Omsk region. As a result of its launching, the effective projects on using coal ash in agriculture, for ash ponds reclamation are being implemented. To ensure regulatory solution to the ash handling problem the standards on use of coal ash for road construction, territory levelling and improving the agricultural lands have been developed. It should be noted that development of a regional program that really works for addressing the coal ash handling problem in Omsk region would be impossible:

- without understanding by management of the JSC "TGC-11" the need and the complexity to address the coal ash handling problem for increasing the ecological and economic efficiency of work of power companies;
- without support of the Presidential Representatives' apparatus in the Siberian Federal District;
- without close interaction of JSC "TGC-11" management and government of the Omsk region;
- without skilled specialists in the field of coal ash in "TGC-11";
- without willingness to solve it by management of JSC "TGC-11", government of the Omsk region and apparatus of the Presidential Representatives in the Siberian Federal District.

In recent years, the CJSC "ProfCement-Vektor" shows its activity relating to creation of a civilized market for trading commodity products made of ash, but not trading ash and slag from thermal power plants with unstable properties, what other organizations do.

There are certainly other positive examples. However, for Russia as a whole, this is clearly not enough.

4. EXPERTISE OF THE PROJECTS OF COAL-FIRED POWER PLANTS

To effectively address the coal ash handling problem it's required to conduct an external independent expertise at all levels of the project, starting from preparing a technical enquiry. It is worth noting that customers either rarely attract external experts to address relevant issues, relying on their own forces, or ignore their advice, or engage experts who are not quite skilled in this area. About all this testifies decisions made at TPPs, associated with the operation and modernization of ash removal systems. Cost of the project expertise is very small compared with the huge damage could occur at implementation of ineffective and ecologically not friendly technologies of coal ash handling.

Retrofit of the ash removal system at Troitskaya SDPP. For example, in the technical enquiry for development of a basic project on retrofitting the ash handling system of Troitskaya SDPP being a branch of WGC-2 using dry ash technologies it's written that the current wet ash removal system remains as an emergen-

cy one. When it is impossible and/or unreasonable to retrofit the system for evacuating bottom ash from the boiler throat, bottom ash is evacuated using the existing wet ash removal system and transported to the emergency ash dump. Thus, after retrofitting there will be two ash removal systems - wet and dry in parallel operation that will inevitably lead to a significant increase in operating costs associated with ash handling at the power plant. If the transfer to dry technologies in the ash removal system will not be completely implemented, the ash removal system will still remain as a point of discharge of industrial (oiled, greased, etc.) and surface wastewaters of the power plant. Very important is the fact that at the same time there will be both ash disposals - dry and wet (the emergency) in operation, making even greater ecological damage to the environment

and the people living in residential areas. Such a system will never pay off! Who needs this modernization?

Retrofit of the ash removal system at Reftinskaya SDPP. As a result of the peer review there were considered two main options of the ash removal system arrangement after 2010:

1. The existing wet ash removal system remains and expands.
2. A system with removal and shipment of dry coal ash and storing the unclaimed part at the dry ash disposal site is created.

In the second option, for assessment of technical and economic parameters only dry ash removal and storage technologies have been used.

Table 1 shows the main indicators of wet and dry ash removal systems.

Table 1. Main indicators of wet and dry ash removal systems

Indicators	Wet system	Dry system
Area for the ash dump expansion, ha	456,0	—*
The total capacity of the ash dump, million m ³	137,2	185,3
Ash dump to be filled, years	20,6	36,0
Length of embankments, km	49,4	—
Volume of stone for construction of dams, thousand m ³	4660,0	—
The cost of the dam (without VAT), USD million	269,0	—
Valuation of options for ash removal system (excluding VAT), mln USD	448,0	241,0
Payback period of the investment project	Never!	Depending on the volume of ash sales

* — for constructing the dry ash disposal the filled ash pond sections are used

Expected implications of dry ash removal system introduction

- improving the environmental situation in the place of the power plant location;
- no need to expand the ash dump and saving 465 hectares of wood;
- reduction of water consumption at the power plant as a whole;
- prolongation of the ash dump filling of 1.8;
- reduction of the cost price of electricity generation;
- increase in ash sales.

Main results of retrofitting the ash removal system at Reftinskaya SDPP [8]:

- the existing wet ash removal system remains as a reserve one;
- wet bottom ash removal system, which should work in parallel with the dry ash disposal, is under project;
- the following is initiated: creation of the dry ash removal system from ESPs hoppers, its pneumatic conveying to the silo, partial shipment of dry ash to consumers and storage of the unclaimed part of dry ash at the dry ash disposal site;
- appreciation of the cost price of ash handling;
- appreciation of the cost price of electricity generation;
- increased water consumption at the power plant as a whole.

Unfortunately, management of WGC-5 decided to leave the existing wet ash removal system as an emergency in addition to the created dry ash removal sys-

tem, rather than using the best available technologies of bottom ash removal at TPPs used in both developed and developing countries for decades. This approach leads to higher prices for the ash handling at Reftinskaya SDPP, further environmental degradation and reduction of technical and economic parameters of TPP as a whole. But that was the contrary goal.

5. INFORMING THE PUBLIC ABOUT THE BEST AVAILABLE NATURE PROTECTION TECHNOLOGIES IN POWER INDUSTRY

For effective addressing the coal ash handling problem it is very important to inform all social groups about the positive experience in introduction of the best available technologies world-wide for their useful application. One of the main goals of information support is changing the negative attitude of public to a positive one relating to utilization of coal ash in various sectors of the economy replacing natural resources. An equally important goal is forming the opinion among representatives of energy companies and enterprises of various sectors of the economy - existing and potential consumers of ash as well as environmental authorities, that coal ash is a valuable mineral raw material of the man-made origin, but not waste after making its properties and conducting the appropriate certification. For this purpose in 2010-2011 under MPEI Development Programme IACEE MPEI created the Constantly Updated Electronic Information System of the Open Access

"The Best Available and Perspective Nature Protection Technologies in the Russian Power Industry" both in Russian and English - <http://osi.ecopower.ru>. The System was registered in the Rospatent of the RF as a data base in 2013. It contains the results of the system researches on various aspects of ecological problems in power engineering, represented by the authors to the Editorial Board of the System; proceedings of international and Russian workshops and conferences on ecology in power engineering, expert analytic materials on different directions of nature protection activity. Great attention at development and updating of the System is focused on issues related to CCPs handling. In addition to that, a section "Ash handling" is a part of the World Wide Coal Combustion Products Network (www.wccpn.org).

Public opinion can significantly both positively and negatively affect the legislation change in the field of coal ash, as well as the attitude towards this issue. For example, the ash spill at the ash pond of Kingston power plant (Tennessee, USA) in 2008 was very intensively covered by media. At the same time, the inhabitants purposefully formed a very negative opinion about beneficial use of all types of coal ash, although a failure of the dam at the ash pond of one power plant happened. Instead of that the citizens could campaign for a ban on constructing the new wet ash removal systems and lobby for operating the existing ones for 5...10 years. We can only guess about possible causes of such an information media attack. Maybe a raw lobby paid for that, but maybe somewhere election was imminent and it was necessary for some candidate for deputy or any party to promote themselves. However, the media impact on society after December 2008 resulted in significant adverse changes in U.S. legislation relating to CCPs. A Program C2P2 (partnership in the field of coal combustion by-products) was closed. However, the problem was not that the coal ash is a hazardous waste falling into a river resulting from the dam failure, but the problem was that wet ash removal systems are always a potential threat to the environment, since they are complex hydraulic structures, in which the accident always leads to serious environmental degradation.

Organizing and holding the international scientific conferences and workshops is another way of informing the public on the best available nature protection techniques. For example, the proceeding of this V International Ash Conference will be also placed in the mentioned Open Information System on the Best Available Nature Protection Technologies in the Russian Power Industry in the section "Ash handling" both in Russian and English.

Listeners are informed about the Best Available Nature Protection Technologies during their training and retraining in the Center of improvement of professional skills and retraining called "Ecology of Power Engineering" of MPEI (CPPEE MPEI). Listeners of the Courses receive up to date information on the best solutions, technologies and approaches in the field of coal ash handling, as well as perform a thesis on retrofitting the ash removal systems of coal-fired power plants, tak-

ing into account the best international practices in this field.

5. ON HARMONIZATION OF LEGISLATION OF COUNTRIES OF THE WORLD ON THE COAL ASH HANDLING PROBLEM

Harmonization of legislation on the coal ash handling is one of the essential conditions for the effective use of the world experience in BAT application not only in the field of coal ash, but also in ecology of power engineering of coal-fired power plants in general. Lack of harmonized legal and regulatory documents is a real brake not only for BAT implementation in the field of coal ash handling directly at the power plant, but also for trading commodity products made of ash, which negatively affects the timing of repayment and investment attractiveness of BAT introduction in the field of coal ash handling outside the power plant

6. CONCLUSION

For effective addressing the coal ash handling problem in Russia it's required to implement the program-target method, for which it's necessary to meet the following primary challenges:

1. Create a single state responsibility Centre for coordinating the activities of all Federal and Regional Ministries and Agencies relating to efficient solution of the coal ash handling problem.
2. Create the holistic and constantly updated legal framework in the field of coal ash handling.
3. Provide state funding of the permanent research in the field of coal ash handling.
4. Initiate harmonization of Russian and foreign legal and standard technical documents in the field of coal ash handling.
5. Provide public funding for updating the Constantly Updated Electronic Information System of the Open Access "The Best Available and perspective nature protection technologies in the Russian Power Industry" in Russian and English on the basis of updated results of system research of domestic and foreign experience in addressing environmental and coal ash handling issues.
6. Arrange close cooperation between the management of power companies and Federal and Regional Authorities relating to beneficial use of coal ash.
7. Organize close interaction between management of energy companies and Federal and Regional Authorities on beneficial coal ash use.
8. Provide matching the qualification of staff of power companies and other organizations, dealing with coal ash handling, to the modern requirements.
9. Inform the public through print and electronic media on the best available technologies in the field of coal ash handling.

REFERENCES

1. <http://www.flyash.info/2013/171-Heidrich-Plenary-2013.pdf>
2. http://www.cea.nic.in/reports/articles/thermal/fly_ash_final.pdf

3. <http://www.aaaa-usa.org/Portals/9/Files/PDFs/revisedFINAL2012CCPSurveyReport.pdf>
 4. **H.-J. Feuerborn, S. Göhring.** VGB/ECOBA report to ASHTRANS, September 2-3, 2013, Copenhagen, Denmark.
 5. http://www.adaa.asn.au/documents/ADAA_Mship_Report_2012.pdf
 6. **V. Kumar.** Resolution of complex issues of fly ash utilization: Successful case study of India // Proc. IV Int. sc. prac. workshop "Ashes from TPPs – removal, transport, processing, landfilling". Moscow, April 19-20, 2012 — М.: MPEI-Publishers, 2012. — p. 132-137.
 7. **РД 34.27.109-96.** Методические указания по проектированию систем пневмоудаления золы от котлоагрегатов, установок отпуска сухой золы потребителям и отгрузки ее на насыпные золоотвалы / Вишня Б.Л., Путилов В.Я. АО "Уралтехэнерго", Екатеринбург, 1997, 170 с.
 8. **N.V. Gavlitin, Y. Kolomiets.** Environmentally sound ash handling technologies. Case study based on Reftinskaya OJSC "Enel OGK-5" project // Proc. IV Int. sc. prac. workshop "Ashes from TPPs – removal, transport, processing, landfilling". Moscow, April 19-20, 2012 — М.: MPEI-Publishers, 2012. — p. 152-155.
- V.Y. Putilov, I.V. Putilova, E.A. Malikova.** Key issues of coal ash handling in Russia // Proceedings of the V Conference "Ashes from TPPs: removal, transport, processing, landfilling", Moscow, April 24–25, 2014 — М.: MPEI Printing House, 2014. P. 153 – 158.